>> KATHIE LIBBY: Welcome back, everybody.
We will start in 60 seconds, 59, 58, 57... he was warned.
Okay, everybody, welcome back.
We are about to continue on with our session on biologic soil crust.
And we welcome back Janis Boettinger, and Fee Busby, and Matt Bowker.
We welcome back those of you who web camming or on the Internet.
We apologize, I understand we had some Internet issues earlier today.
We will be posting information on where you will be able to re-see the live stream that is made available and where transcripts will be available.
We will post all of that information for you.
In the meantime, we are moving on from the question of what do we know about biological soil crust.
We have a lot of really good information on that this morning.
And the session number two, what are our management options?
These are what we are moving towards.
What can we do to achieve some of the goals and sometimes conflicting goals that we have?
So we are going to start off and I think we are going to start off with Kim.
With the question, what kinds of management action can support biologic crust recovery?
And how long does it take for crusts to recover?
As a reminder, feel free to forward on paper or email specific questions as we go through and we'll cover those for you during this session.
So, management actions that can support biological crust recovery and how long does it take for the crust to recover.
>> DR. ANDERSON: I think with, that what I will start off with first is how long does it take for recovery.
When I was in college, they discussed how long it took for soils to develop and everything, and so that's always been in the back of my mind.
This site right here, is an area -- I think it's called deer trail, it's here on the monument.
You can see that there's a post kind of in the middle of this site this is an area where they came in and drilled, I think for gas exploration.
My understanding, talking to one of the individuals that was aware of this project, they went in, scraped off this site, and took everything off, brought in gravel and then drilled a well.
This was put in, they actually welded the date on this post, and it was put in October 26th, I think, 1966.
So I went back out to this site, you know, it's come back with all the sage brush and rabbit brush.
As I was looking around -- next slide, please.
There was a crust around here.
And I thought this is interesting that this site was actually scraped off and graveled and, you know, this has come back in about 40 years time.
So I did some measuring, on these -- a number sites and locations on this site.
Next slide, please, and I put together a little -- some growth curved and like measuring the growth of life is something I have been interested in since I got into lichenology so I took some

of the measurements in lichenology, and I applied it to the pinnacles.
I looked at -- I had an upper site where the -- where they put the oil well pad in this lower site.
Anyway, the -- the gist of this is that, you know, we started seeing pinnacled crusts after four years on this site.
So I think, okay, well, crust takes about 40 years to develop.
Next slide, please.
Back in the '70s, it was actually my ecology professor, he looked at endocarpon pusillum, it's quite common here in monument, and telegraph, a 5-mile area.
He looked at the -- how fast it -- granted this was a laboratory experiment, but he looked at how fast the mar species would grow.
And so you can see there that after one year, the squamules, the lichen, squamule would get to 2 millimeter diameter and patches to 10 centimeters and the perithecia, which is where the spores are developed which helped in the propagation of the lichen, the perithecia become common after one year and the spores will develop shortly after that.
Next slide, please.
So this is a photo of endocarpon pusillum on the monument.
This squamule here is about the 2-millimeter size.
So based on the research done, you can get these in about one year.
So that's -- excuse me, we are finding in lichenometry, I talked to my major professor a couple of years ago, I was working with the paleontologists here on the monument.
We were trying to figure out how long the dinosaurs had lichens growing on them, how long they have been exposed to the atmosphere.
I talked with my former major professor and he had indicated that they were doing some new research and they are finding that lichens actually are growing a lot faster than what has been traditionally thought, with some research that he was doing.
So you know, we were looking at a lichen that was about 30 centimeters in diameters.
He said, it's about 30 years or something like that.
Not as old as what we had thought.
So that kind of blew our -- the research that I was doing with the monument paleontologists.
We realized that the bones he was looking at, actually hadn't been out that long of time and he had an issue with, you know, deterioration and things like that.
Next slide, please.
Okay.
This is -- this is Watson cabin, hackberry.
Right here is tortula.
This' some tortula moss over this, along with some little cactus.
Okay you have moss on a roof here that had been -- there are a lot of number of dates in there.
I think the oldest one was 1921.
So they put a sod roof on here.
You have tortula moss growing up here and cactus.
80 years old.
That takes 80 years?
I'm making some so 80 years to grow that.

This is a ring tank.
They did a lot of these on the crust, probably crossed BLM in the 1960s.
I came across this one in -- let's see it was 2010 but I think it was in big bounds area.
You can see it's starting to develop cryptogamic soil in there.
I would guess it ended in the 1980s, so the crust in there, about 30 years old.
Next slide, please.
This is -- I like this one because you've got a large composition of lichens growing on gypsiferous soils.
You get a lot of species on these soils.
They are all -- they are all part of the cryptogamic soil.
This is where it's found.
As Matt mentioned earlier, the right-of-way along highway 89 between here and Page.
Prior to the 1950s, the main travel route actually went up Johnson canyon.
This is east of Johnson canyon.
They put the road in, when they were building, getting ready to build plan canyon dam.
So this road was put in in the mid- to late '50s.
And you can see that in -- there are areas along this road where you can see that a bulldozer had actually gone in and pushed up some of the soil on the side of the road while they were doing this whole roadwork.
I put this damage at about 50 years ago.
So anyway, looking at these sites here on the monument, soil cryptogamic soil recovery, it doesn't take the thousands of years I was told in college, a few decades, gypsum soil is very good for lichen diversity and getting the cryptogamic soil back on to the site.
The other things, I just take it for face value.
If you haven't put value in a trough for 30 years and you have lichens in there or other cryptogamic soil, you have 30 years of age on those.
So --
>> Before you move to, that so we have done a bunch of these experiments -- is this on?
>> DR. BELNAP: We have looked at a bunch of old disturbances that we knew the ages of, similar to what Kim was just talking about.
We have done them around the West, and with the idea that, you know, there were emergent principles that we could come up with.
So we have sites in the Mojave and the Sonoran desert and sites in New Mexico and we have sites here.
We have got sites there and sites everywhere.
We came up with a whole, big bunch of them, and basically, the emergent properties weren't surprising.
One was what kind of soil was it on?
And so if you had a clay or a silt soil, something that held water a little longer, and it was a little more stable, like gypsum, that you got much faster recovery than if you had a Sandy soil that jiggled and wiggled and moved around in wind.
Certainly climate and that's a ton, these guys are only metabolically active when they were wet.
If you were in an area where it rained more, it reacted more.

So 198s to 2000 was a very wet time.
The years since 2000 have been a very dry time.
And so, you know, you really need to think about that when you look at these date of disturbances, but in general, if you go up in elevation, you will find much faster recovery.
And certainly the cyanobacteria came back faster than the mosses, and we know that when we look at the succession of these guys coming in.
Interesting, even when we looks at the lichen, it was the gelatinous lichens, the reds and the greens lichens, they were all much, much later.
And so when I first started doing soil crust stuff, the first thing I did was go out and scalp off a whole bunch of plots.
I can go back 40 years later and look at the Mottes.
The green lichens are still not back.
Calima is doing okay, the cyano is doing okay.
It's hugely variable on the climate type and all of that will feed into what the recovery time is.
The other thing is you need to look at what function you are looking for.
So bumpiness is very important when you are thinking about water retention or you are thinking about seed retention, you know, then that pinnacle-ness really matters to get back.
That comes back very quickly.
It's not very long until you get a nicely pinnacled crust but it doesn't mean you have the lichens and the mosses on it.
If you are worried about nitrogen input, then you need to be concerned about the later stage when they are getting darker and darker and the lichens are coming in.
You want to know what the surface is going to give you.
When they recover is what it is you want from them.
So there's going to be all sorts of -- you know, places where water pools.
It's going to recover a whole lot faster than if you got somewhere where it ran off.
Again, it will be water availability.
So there's a lot of factors that come in as to how fast the crust is going to recover.
>> DR. ANDERSON: And my thoughts on management, you know, based on what I have seen across the monument and some of these places just, if that's what you manage for, you want to manage for crusts, it gets better when it's ready.
>> KATHIE LIBBY: Anything else on that?
(Off microphone comment).
>> It's not just a matter of grays, not grays.
There's the intensity of grazing, how many AUMs are on the landscape at a time.
There's also seasonality, most -- most range here is winter range but there are some year-round pastures and there are some warm season grazing as well.
And respiration cycles are things that be tweaked.
Just generally speaking, winter grazing is less impactful than summertime grazing from a crust standpoint.
Fewer -- fewer head would also be beneficial, it's just decreasing the pressure on the soil crust, and longer rest would enable some areas to recover their crust functions to some degree.
I don't really think you have to -- you don't have to make the decision to manage floor crust per se, but you may want to, with a particular crust function in mind, like -- maybe you have

soils and you want them to restabilize, you may want to work that into your management prescription and then take action to manipulate the grazing intensity or the timing so that that can happen.
>> DR. BELNAP: And the other thing too, livestock, fortunately or unfortunately don't use the landscape in a very even way.
So you can put a group of cows out on an allotment and they might all just stay in one place.
So one place may get really heavily utilized whereas other places done.
So that's also a big consideration too.
You know, maybe you want that.
Maybe you don't.
But that needs to be put into the equation.
And the other thing is drought.
You know, you can have all the management plans in the world that work under average conditions, but when there is an intense drought, action really needs to be taken to pull the use down.
It's just so much of the impact happens in a short time, when things are vulnerable like drought.
And so it's not saying, you know, reduce the numbers all the time, everywhere, no.
But there are conditions under which, you know, really that we know where we really need to take a hard look at what we are doing and how we are utilizing the landscape under those exceptional circumstances.
>> KATHIE LIBBY: Anyone else on that question?
Okay.
And do keep in mind if you have some questions that you have written down, just show us and someone will come capture them for you.
Next question, are there areas where biological soil crusts can be conserved, restored or preserved.
The second part of that is where does it not to be conserved, restored or preserved to restore the ecosystem health.
I think both Matt, Janis and Kim.
>> DR. BOWKER: One way to think about this or one way to think about what is the crust attendant place is it should satisfy two criteria.
It should have the potential to have at least some crust, okay?
And it should also in the absence of crust be easily degraded, for example, easily eroded, okay?
So if you could find those places on the landscape that seem to really depend on crust to prevent erosion, those could possibly be places to focus your management activity to prevent erosion.
>> DR. BELNAP: And that would cover the restored, preserved and conserved because they don't necessarily have to be already in that condition.
They could be something that's very vulnerable to that and so that might be a place where you really don't want to mess with it, as opposed to another place that would be more resilient.
>> DR. BOWKER: I will add a little bit if no one else is chomping at the bit.
If you have an idea of what the crust potential is, and if you look in the soil survey, there are estimates of wind and water erosion susceptibility.

So it's just a matter of juxtaposing those areas that are susceptible to wind and water erosion and have the potential to support some crusts and those might be a smart way to start funding your crust dependent ecosystems.
Or your most crust dependent ecosystems.
>> CINDY STASZAK: Yes, the soil map unit will be a great predictor of the potential for biological soil crust.
My doctoral student and I recently completed a study in Canyonlands National Park where we took the soil observations of the soil survey view, they were more than 600 soil observations, you know where they dug a hole.
They described the soil and part of that was a description of the level of development of the biological soil crust.
And the best predictor of the level of development of the crust was the soil map unit.
Second most were some land stat, remote sensing band ratios that indicated soil parent material and the third thing was elevation.
Basically which is related to climate.
So the higher the elevation, meaning generally the weather, the cooler the site, the greater level of crust development.
So having an inherent capacity of the site to develop the crust is the primary thing to consider.
If you are on clay badlands, for example, don't expect there to be a crust.
It will probably never get there.
But there might be other things you want to consider there.
There could be a physical crust that forms on those types of soils, which could help that site be stable.
And then secondly, the level of disturbance, definitely, some areas can look -- let's face it, really trashed.
Why do they do that?
Maybe it's because those areas that have been impacted have suffered greatly from the description of that crust.
>> KATHIE LIBBY: Okay.
I think I will interject with a couple of questions from the our great listening audience.
How does drought make biological soil crusts more vulnerable to impacts from grazing use?
>> DR. BOWKER: Crusts are really cool.
They are different from plants in an interesting way.
When they are wet, they are active and they have this amazing ability to completely dry out but not die, but they shut off.
They are not doing anything in the dry state.
They are not growing.
So there's a prolonged period of time when they lack the ability to grow.
They are not rebuilding themselves and helping to repair damage from various stressors.
Stressors may be the sun.
They are sitting out there baking in the sun and degrading but then also if a human footprint, a deer, a cow, or something comes and steps on them, they don't have the opportunity to be active and grow and repair themselves.
>> DR. ANDERSON: And that activity, this loosens them and they die, if get buried or upside

down, they will die.
At times where it's not raining, it makes them much more vulnerable that way.
Plus the loss of their -- so Matt referred to chlorophyll before, that's the pigment they use to capture sun light and convert it into carbon and so when they lose that chlorophyll and they lose it when they are exposed to ultraviolet rays and sun, and they can't repair it unless they are wet.
When they get wet, they are much less able to photosynthesize.
So the greater that dry is, the more difficult for them to recover.
And they get crispy, right?
You step on a lichen and it's really dry, it's crispy.
It's very different than if you are stepping on it when it's wet.
>> DR. ANDERSON: There are some that develop a thick cortex.
They don't all dry out.
>> DR. BELNAP: That a my best imitation.
>> DR. ANDERSON: That's good.
It looks just like it.
>> DR. BUSBY: I have walked across many areas of crust.
>> DR. BELNAP: No, Fee!
I don't believe it.
>> DR. BUSBY: If they are wet, it's like walking across a sponge.
If they are dry, they crunch.
The fact that I'm not getting rained on, that's how I know it's a dry day.
>> KATHIE LIBBY: Okay.
So the other -- there's been reference to winter grazing, perhaps as a management method, and the question is:
What is meant by winter grazing?
And what signals the end of winter?
>> DR. BELNAP: That's a good question.
The reason I say it's a good question is the definition of winter grazing season is not necessarily what we all think of as winter.
It often can go into late spring.
>> DR. BUSBY: And start in late fall.
>> DR. BELNAP: So when Matt referred to this as being the best time, the best time is when the ground is frozen.
The best time from the plant view point is when they are dormant.
So this is a big issue and something that I have always tried to put forth as the idea that to get the livestock off of an allotment, a good month or so before the rains most often stop.
So that can be variable, depending upon where you are.
Sometimes that means May.
Sometimes that means June.
You know, it is just really variable but on the average, that gives the resources a chance to get a breather, still having rain to recover before they get summered, where they don't have rain to help them.
So that's something that I have been trying to sort of get the idea into thinking, but it

doesn't -- it hasn't gotten far.
But I do -- I mean, this is a big question, because wintertime is the very best time, but we have extended this definition into a very broad one that is not traditionally what we think of.
>> KATHIE LIBBY: Okay.
So Jayne, on the winter grazing thing.
>> DR. BUSBY: The research work done by USGS scientists, Greg Lesby on badger wash in Colorado which is just north of grand junction, north and west of grand junction, and they did these grazing studies for --
>> DR. BELNAP: 20 years.
>> DR. BUSBY: About 20 years.
It was a long study and it's not common for us range managers to do those kinds of studies that long.
When it was all said and done, in that precipitation belt, the recommendation was that grazing on those sites, it's the desert shrub site, if it ended by February 5th, then all the plants could recover.
Now this was a precrust grazing study as far as I know, Jayne.
>> DR. BELNAP: Yes.
>> DR. BUSBY: Before we knew about them.
So in that site, it provided in that month.
A month of six weeks of still fairly good soil moisture.
So that the plants could impact, would grow and be very productive.
So the system, the healthiest system were those where they would move them.
>> DR. BELNAP: And that was the same at the expert desert experimental range, again salt bush.
This was a cross study that didn't ever get published that Kim Harbor did, but it was the same February 15th.
That was really the date where things recovered the best and weren't really that impacted but just the grazing went from February, March and April and then you started to see it.
>> KATHIE LIBBY: So I think you just answered this question, but to be fair, I'm going to let you say that, yes, that was the answer.
The question is:
In theory, winter grazing is better, but do you have any data showing that this theory applies in practice?
>> DR. BELNAP: Yes, I think we answered it.
>> KATHIE LIBBY: You answered it.
I wanted to make sure.
>> DR. BUSBY: And the Lesby, I think it's '72 and I think it's in the journal of range management.
It's a really good article.
And I recommend everybody to go to the rangeland west website and pull up that article.
I don't know the volume or the page number off the top of my head.
It's worth reading.
>> KATHIE LIBBY: Thank you.
Do you have any specific examples of where livestock grazing is compatible with fully healthy, fully functional biological soil crust?
>> DR. BUSBY: Do you want to speak to the Harper studdie?
>> DR. BELNAP: No, you do it.
>> DR. BUSBY: I'm not that familiar with it.

Go ahead.
>> DR. BELNAP: Well, I mean, one is the example I just gave.
You know, it was all about timing.
And where it was true winter grazing, there really -- they saw very little impact to either the soil crust or the plant community.
I mean, it was very, like -- and then also, in -- we have the example in Canyonlands National Park where we have a never grazed grassland and it was because of the rock walls and the water that made it difficult to get animals in.
Then right across that rock wall, we had a pasture that was grazed in winter only and the reason is, there was no water in there.
So they had to have snow on the ground.
And then right over the back rock wall was pretty much typical, you know, grazed in the beginning year round and then later, you know, was actually put under, you know, BLM rotations and things.
And, again, you see a real striking contrast in the functioning of the soil crust among those three places, that winter grazed only is in very good condition in terms of a soil crust.
There's a little fewer lichens that you would expect but not a ton less.
And accordingly, there's a few mosses than you might expect, but considering the level of use that that place had.
Because I talked to the rancher that was in there and he said they totally ate everything.
They stepped on every square inch when they were in there.
So -- and to the point, he said that he had to finally fence the cows out so the horses would have enough to eat.
That's also where they camped.
They were clearly utilizing that area really heavily, but it was in the winter, and the snows protected that surface.
So I think, you know, too, that again, we go back to this idea that if you've got -- if you want the optimal, it's not necessarily numbers.
It has a huge amount to do with timing.
>> DR. ANDERSON: Thinking on that question, at least where on the monument, other than, you know, some sites maybe on the chinley, and this may go to the question of how much is necessary.
How much soils are necessary.
Of all the allotments that I have been on, you can find cryptogamic soil on every one of those soils with cattle grazing.
Granted, it's a shrub or something like, that they are there, but like I said, the question addresses how much results.
>> DR. BELNAP: And I think we need to do that question to answer that question, because when you say fully functioning, healthy, whatever, you know, well, that depends on the management goal and the service from them.
If I want nitrogen fixation to be the max, I have a very different crust goal than if I just want to stabilize my soils.
And so, you know, I need to understand what people are -- that the manager is aiming for, before I can say here's how much grazing you can have or not, and you need to know the soils and you need to know the rainfall and so there is a possibility, a real one of developing the recipe, but you really need those specifics.
>> DR. ANDERSON: I look at an individual, an individual sitting are a sagebrush, that individual is probably functioning but the whole system, how much more do you need?
>> DR. BELNAP: Exactly and that will need.
I hate to keep saying that.
(Laughter)
Job security.
>> KATHIE LIBBY: So one more and then we'll go back to the formal questions.
You suggested and I think this is to Matt, but you can all help him if you like.
You suggested we can define where crust can be restored.
Do you have an estimate in the acres in the monument that can be preserved?
>> DR. BOWKER: No, I don't.
(Laughter)

>> KATHIE LIBBY: That was easy.

>> DR. BOWKER: No, I haven't done that.

Why don't you take that?

>> DR. BOETTINGER: To calculate that, we have the full survey data and maybe Shane can correct me if I'm wrong, but when we are at the point where we have a set of very good ecological sites with state and transition models and those descriptions include biological soil crust, we have the map of the spatial extent of the different soils that are related to the ecological sites.

We should be able to calculate what are the acres that can be restored if we target specific oil units and ecological sites.

>> KATHIE LIBBY: Okay.

So I think if I'm keeping track here, our next formal question is:

What is the potential for biological soil crust restoration?

>> DR. BOWKER: I think the potential is great.

In fact this is one of my favorite research topics right now.

We are actually growing biological soil crusts in the greenhouse, and both Jayne and I are active in this area.

There's a lot of research around the world right now on this topic.

Especially China, really the US needs to catch up with China because China is leaving us in the dust, literally.

No pun intended, I guess.

So I have a photograph.

Can we bring up the slide?

I just want to show you that it's one of the series of blacklands.

Keep going.

That last one.

There.

Yes.

Okay.

So what we're looking at here, this is the same pot at one month, two months, three months, and four months.

And what we did at times zero was basically took like half a teaspoon of mosses, dried out moss collected from crusts and our goal really was to grow mosses.

We were interested in that component.

And what we found was that if you take away everything that limits these crusts, like give them all the water that they need, and giving them the nutrients that they need, they move fast.

Okay?

They are not hard wired to grow really slow.

Rather, it's the environment that makes them grow slow in nature.

So as we went through time, through about four months, we were able to, in our best treatments, increase the moss cover six times over the original and then quite by accident we started growing nitrogen bacteria and most of the stuff you see there are the nitrogen fixtures.

We didn't even mean to do that but we did it anyway.

We thought that was a pretty sweet bonus that we are growing nitrogen fixtures.

Right now, you know, this is small scale stuff and we are trying to learn how to grow them.

Meanwhile, in China, and also our collaborators at Arizona State University, people are learning how to grow large quantities of cyanobacteria.

In fact, in China, they have gone out to things like bio reactors and outdoor ponds and have been able to put cyanobacteria out.

On the moss end, you know, we don't know what the upper limit is.

I think the question, can you grow crusts is answered, yes, you can grow crusts.

They are right there.

The question is how much can you scale up?
Can you -- can there be such thing as a moss farm?
Can you grow mosses just like a contract farmer might grow out a crop for a seed?
You know?
For example, blue grama or some graft for restoration.
Can you grow a crust like that?
The answer is maybe yes.
>> DR. BELNAP: Let me jump in about the Chinese and the cyanobacteria, I went to China to see theirs and they have these giant, raceway ponds in which they can produce 20,000 kilograms of dried cyano in a month, once their production starts growing.
It's phenomenal!
And then they support -- they have these big trucks and they spray them out and within three or four years they have a gorgeous, cyano crust with mosses coming in.
It's really, really incredible and they are using this to stabilizing moving sand dunes so nothing like we.
Have we don't have moving sand dunes.
We've got it easy.
Our stuff is pretty stable compared to a moving sand dune.
It's really just amazing what they are doing over there.
>> DR. ANDERSON: A few years back, they were working on slurry stuff.
They were trying to do it on a larger scale.
>> DR. BELNAP: No, what happened, they dried it down.
And this guy said you can't dry it down without expecting very large mortality.
He said, especially since when you apply it, one, a lot of them don't wake up again.
And two, a lot of it just blows and washes away.
>> DR. ANDERSON: Yeah.
>> DR. BELNAP: And so it's not sticking.
When you apply it as a slurry, the success is phenomenal.
So Mr. Moss.
>> DR. BOWKER: The thing I had forgotten to say is we are learning how to grow them and really the next big question are what can we do to help them take -- or what's going to happen when we take these lab grown guys and put them in the harsh world.
Will they survive?
And what are the things we can do to help them survive?
And also the scaling up thing but the simple answer to this question is the potential is huge, and I think collectively we should be pursuing it big time.
>> DR. BELNAP: And I want to, have like, c-130 airplanes dumping cyanobacteria everywhere across the landscape.
The fire retardant airplanes, why not?
They are bored during the winter.
That's perfect.
We will put them to work.
>> DR. ANDERSON: And also in response to this question, a lot of us have been to range exposures.
It's typically put in for the simple reason that the BLM or the natural resources conservation service, the Forest Service would like some kind of a references as to what would occur in an area without grazing.
>> DR. BUSBY: Just a fenced off area.
It can be large or small.
And a lot of us have seen those in a very short period of time that we're very -- we were heavily grazed before and they are still heavily grazed

outside the area that fairly quickly will have a very substantial biological crust all over the surface soils.
So I think Kim said something earlier, and I was talking about it at lunch, there's a tremendous amount of crust on these lands right now.
They happen to be in protected areas whether that be a thick cluster of sagebrush or something like, that but you look in the sagebrush, underneath the sagebrush plants and you see all of them, including the mosses which evidently are the laugh thing to come back in from the disturbance.
And so the seed are there so to speak, or for recovery, across the whole landscape.
And so what you are talking, about I think is important, but I don't think we should dismiss the count that we already have the potential on most of these range lands for crust to spread.
The recovery is there.
It's under the sagebrush plant waiting to be able to creep out.
>> DR. BOETTINGER: You have to keep in mind, if you have an area that's disturbed and the soil is lost, the spores may not be there to regrow.
So the ideas of perhaps repopulating the area with the spores, of the cyanobacteria and the mosses would be a good idea to help accelerate the recovery of areas that have been dramatically impacted.
>> KATHIE LIBBY: So this whole area of restoration and receding has garnered a lot of interest from our public.
Excuse me, some of these you may have already alluded to but I want to raise them in case there's more to say.
Does the panel have recommendations on how to recede native vegetation following a fire in the way that protects the seeds without damaging the soil crust or promoting cheatgrass and red bloom?
[Whistle]
>> DR. ANDERSON: No.
>> DR. BELNAP: It varies and it depends on your management goals.
Certainly whatever you can do to minimize the soil disturbance, like, you know, no till, drill.
We didn't ever try them.
I would love to see people try them.
We just sort of immediately go to things that churn up the soil surface.
And, you know, so it's that kind of thinking, but, again, you know, what is the management goal?
It's going to have to be a huge question in, that because for instance, I have a very different approach if I was worried about max wasting of soils on hill slopes after fire.
Suddenly I would be going in and downing trees across the slope.
There are all of these things that I would respond to very differently depending on the situation.
>> DR. ANDERSON: For example on the buckskin fire, we couldn't put a drill on that.
We put a chain over it so that we could get a little microsite for seeds and all of that.
We did drop trees, you know, some of the dead trees.
So it's site specific and it depends.
>> DR. BUSBY: Yes, the cheatgrass issue, unfortunately, when you look under most sagebrush plants to find the lichens, you also find the cheatgrass plants that are just pumping seeds into the system.
And the fire basically turns it loose and cheatgrass is what responds.
So if you already have it -- if you don't have it in the system, then what we talked about works quite nicely.
If you've already got cheatgrass in the system and it doesn't have to be very much.
Every cheatgrass plant has an amazing ability to produce a plant.
Which grew from one seed.
It has the tremendous ability to produce seed and you multiply that by all of those little plants hiding under the sage brush plant and you have a ton of seed.
And so that's one of the issues that cheatgrass invasion and why it happens so quickly.
It was already there.

You might not have noticed it, because you may not have looked very close, but it was already there.
>> DR. ANDERSON: The other thing, cheatgrass is considered a winter annual.
So you get your -- you will get growth in the spring and it dies down during the summer and then come up again in the fall and if it has enough time, it will set seed again.
So you can get kind of two growing seasons in one year with it.
>> DR. BUSBY: Yes, the more likely scenario is it's germinated in the fall, over wintered, green, slow growing and as soon as it warms up in the spring, if there's soil moisture, it just explodes and it explodes about two weeks earlier than most of our native plants.
And so by the time the native plants respond and they talk about seeding, by the time the native seed respond, the soil surface is already dried because the cheatgrass is used the water.
>> KATHIE LIBBY: I have a really good one for you.
>> DR. BUSBY: The rest of them haven't been good?
>> KATHIE LIBBY: No, this is particularly --
>> DR. BUSBY: Oh, it's your question?
>> KATHIE LIBBY: Interesting.
How can I grow biocrust in my backyard?
>> DR. BELNAP: Oh, that's easy.
You go.
>> DR. BOWKER: Yeah, you would need a little -- a place where you could salvage some.
Ideally you don't want to go tromping around Grand Staircase and steal the crust.
Maybe there's a vacant lot or somewhere, where you can grab some, it doesn't matter too much.
And then basically, you can crumble that up and sprinkle it over your soil surface and that alone would probably take slowly but based on what we have been doing in the greenhouse, add the water, and maybe you can fertilize one time and they'll grow.
>> DR. BOETTINGER: I teach classes and I love to have biological soil crust in class.
I have a pot in my windowsill of crust I extracted from the highway right-of-way in the monument.
But it was a highway right-of-way.
And I sprinkled it over this pot and I basically -- I think about it maybe once every four months and I put some water on these.
They are maintaining and they are even growing a little bit.
What I like to do is have them nice and dry before I bring them into lecture where then I will spray water on half of them and we will watch the mosses well up and turn green and begin their photosynthesis and we will watch the lichens swell up and see the soil surfaces swell it's an amazing thing.
Just for the entertainment value in your backyard, I think, you should try to grow some.
>> KATHIE LIBBY: And this is not a backyard question.
>> DR. BUSBY: And they don't have to be mowed!
>> KATHIE LIBBY: And they don't have to be mowed.
In fact, they better not be mowed, right?
So this may be already answered but can crusts be transplanted like a grass plug to jump start growth at a restoration site?
It looks like a yes.
>> DR. BUSBY: Yes.
>> DR. BELNAP: Yes, crumble them.
It's very effective.
It's a revegetation technique that we used for years.
And frankly, I mean, it's not hard to find places to salvage because bulldozers are very busy things.
You get there in front of them with your 5-gallon buckets and collect it.
>> DR. BOWKER: We have the big sturdy dust pans and you can get one with two handles on it.

And you can scrape a 2-foot wide swath at a time.

>> KATHIE LIBBY: Good.

And these are not as directly related.

>> PARTICIPANT: You have a rogue site or a mine, or anything else, a common technique for us, we peel off the top 6 inches of soil and stockpile and bring it back.

We do that and I tell my grater guy to take the top inch.

>> DR. BELNAP: Exactly.

>> PARTICIPANT: And when we are done, rake it back across the top.

>> DR. BELNAP: And that's what I had Canyonlands do for years.

So you are doing three levels instead of the traditional two levels and that's exactly it.

>> KATHIE LIBBY: Good.

A cottage industry is growing here.

Has there been research into quote/unquote artificial methods of soil stabilization, scattered straw, soil binders to help jump start soil crust at a restoration site?

>> DR. BOWKER: Sure, we are working on that right now.

We have been using this crust crumble method and we have a couple of sites, one in New Mexico and one in northern Utah by the great Salt Lake and we are looking at different soil, mostly polyacrylamides and we are looking at straw in a grid pattern so it's a meter squared and they use this for dunes fixation over there, to stabilize the dunes by sticking in this net of straw.

So we mimic that on a teeny tiny scale.

We made some straw springs around a plot.

So far, our early results suggest that the crusts don't like growing on the polyacrylamides.

The crusts don't seem to like them.

The straw fringe thing, actually, promoted crust growth even when we weren't adding it.

So it captured crust propagules and enhanced them.

I don't know too much about with the scattered straw, with that it would have to be dispersed because you don't want to completely shade out the surface because these guys need light.

Anything that will address the soil erosion problem could have a role to play.

>> KATHIE LIBBY: And this is a two part.

Currently how important and relevant is the issue of atmospheric dust?

Do agencies and scientists recognize biologic soil crust as an important factor in reducing dust in our air?

>> DR. BELNAP: That would be my zone.

Dust is becoming a really major issue in the west.

I'm sure that everyone reads newspapers and they see these massive dust storms moving through southern Arizona and coming up and hitting us.

There are large dust sources that are acute and perennial.

There are smaller dust sources that come just, it seems out of nowhere but they have major impacts on both the source from where they come, because when you see a dust cloud, you can imagine soil nutrients leaving because that's what's in that cloud.

There's huge numbers of human impacts as it moves across the landscape.

We have a lot of highway fatalities.

We've got respiratory disease, valley fever, asthma, cancer when people inhale it.

There are lots of issues.

Lots of lead and plutonium in the dust.

It's not good stuff to breathe.

Certainly not a good thing to drive into because a lot of people get not out of what they drove into.

And then we have this huge problem of water in the mountains when the dust gets deposited on the snow pack, it turns it dark.
So the dust -- I mean, the snow melts a lot faster and leaves the soil exposed to evaporation and so we have a much lower amount of water entering the large streams and rivers.
This is a huge -- becoming a really huge deal as the Colorado River, especially, is over subscribed already and now everybody is going ah, what are we going to do?
Well, we have been tracking back to where a lot of these dust sources are and as I will go back to the previous thing about erosion, the soil crusts are really literally a well-developed soil crust is wind proof.
You can't get anything to blow off of it.
I have a wind tunnel and I run around and I have done thousands and thousands of runs with this thing.
I have never gotten anything off of a well-developed crust.
Anything less than, that you get little bits until you get to fairly recently disturbed stuff and you can get a lot.
And so when you track down these dust sources, they almost invariably have a very low amount of -- or no soil crust present in maces where you have got large places between your plant.
And this is important, because if you've got a big, high plant cover, you know, or you've got giant plants, you don't have a problem and you don't need these guys to stabilize your soil.
Again, it's what service do you need from them?
And so they play a very important role in mitigation, where they are needed for that survey.
And so this is something that is a big deal and it's becoming huge to Bureau of Reclamation and other places that depend on Glen canyon dam and lake Mead for water.
They are looking at how will they stabilize these landscapes and one of the answers and that's one of the reasons we are involved in this cyanobacteria inoculation is how do we stabilize these very large, acute sources of dust and there's some big ones out there that we really need to get our arms around and have it settle down.
I mean, already some areas that are pretty much dust bowl era-type sources that we need to figure out how to stabilize.
Oh, and I should say one other thing about the dust that's really interesting is you can look at lake cores to get an idea of how much dust used to blow around the west versus how much dust is currently blowing around.
And it's -- the signals are really precise and very accurate way of tracking that.
And so the one study that we have shows the levels of dust input into upper elevation lakes if we take a unit of one, because I don't remember the actual unit, in the 3,000 years ago, the level of dust is one.
It stays one, one, one, one, and you get to 1850 and, boom, it goes up between 5 to 8 times.
And then when other things came around, it SARS to relax back and now it's about a unit of six on the scale that I'm on and starting to increase slowly again which I think is reflecting a large amount of energy and gas and oil development and reformation and livestock grazing is not increasing and so it's very unlikely to be that that's increasing the signal.
It's other activities in the West.
And fire.
Fire is a huge creator of dust because it burns everything up.
And so there's nothing to stabilize that.
>> KATHIE LIBBY: Okay.
Thank you.
And before we move on to holistic management approach, I have been holding on to two questions because I wasn't quite sure where they fit in and they may not fit in nicely any place, so I will put them right in here what is the ecological value to the system of the nitrogen fixed by zrsc, forgive me if I only gotten a few of those words correct.
Is it used by the soil crust themselves or vascular plants or stored in the soil?
Vrsc.
Oh, oh, oh.

>> DR. BELNAP: Yes this was asked earlier, about the fate of the nitrogen.
This is quite a conundrum for sometime.
We see more get fixed than we have been able to account for right in the soil.
So we know it's moving from where it's fixed.
The question is, well, where did it go?
We know there's some leaching down but there's not much because we don't have very big rain events and it takes water to leach it down.
We know that we are losing some to the atmosphere, just passively, forget animals or anything.
There's gaseous nature that's going on.
But it still impacts our budget.
Some recent experiments are extremely exciting and might just explain the whole puzzle because basically, three different independent studies one in China, one in my backyard and one in New Mexico have shown that nitrogen in the inner space, a Peter away so 3 feet away from a plant can be transported in the top few millimeters of soil.
So less than an inch is going straight across to the plant and being taken up by the plant.
So finally, we're like, yes!
We can start to trace where this nitrogen is going.
We have a tiny bit going down.
We have quite a lot going up, but we have this transfer going across, that is going directly into the vascular plant.
And, of course, going to be, you know, things along the way are going to be grabbing it too, but there's a significant amount of it showing up in the plant.
And so that's mostly where it's going.
We don't have enough quantification of that lateral transfer to see if it's still -- that budget is balanced or not.
But we're way better than we were because there is a lot that's moving sideways.
And so we are really excited about this because I have been working on this for 20 years, trying to balance this budget and, you know, it's something I have nightmares about, but we're really getting close now with this mechanism.
So we will be following up on that this spring and next spring to try and really get a handle on just how much is moving.
And it especially is moving to grasses.
The reason being that grasses are very shallow rooted and so they are the things that are most close to the surface and right there ready to pick it up.
So great news for grasses.
Oh.
And I should mention that probably the whole mechanism of this movement is by fungi.
And the reason is that bacteria are independent little cells.
So they are not connected.
So they are not going to be a really good transporter.
And I should also add there's no way for the speed of this transform is so great, that this is in 24 hours that they are moving the nitrogen from the middle a meter away.
That's way too fast to pass the diffusion into the soil.
It's got to be bumped.
So bacteria can't do it because they are disconnected but fungi have these nice fungal mats and threads and so it's very most likely a fungal phenomenon that is doing it, which gets us even more excited because fungi can operate at very low soil activity.
You pick up will soil and you think it's dry, but they can still be going because they are so good at working in these extremely dry situations.
This could be a really, really exciting moment for nitrogen cycling.
Can you tell I'm excited?
(Laughter).

>> KATHIE LIBBY: As are we.

>> DR. BELNAP: Yeah, yeah.

>> KATHIE LIBBY: So I will move back to our structured questions because at about 2:15, I would like everybody to take a short break.

And then we'll have another session on issues we still need to think about and do research on and then we'll have public questions again.

So if we don't get to your questions, I've got a couple that I'm just putting aside at the moment.

We will have that opportunity at that time.

Again, management options.

Would this area respond favorably to a planned rotation/holistic management approach?

And how could it be done and what are the benefits and the risks?

I think, Fee, were you going to take the lead on that?

>> DR. BUSBY: Oh, look at the time.

I've got to run.

(Laughter).

>> DR. BELNAP: Chicken!

>> DR. BUSBY: All right.

So let me back up just a hair.

I think Matt talked about the most crust dependent areas, how to go about selecting those, and we have talked about the timing of grazing.

And I -- you know, principles of grazing management or the number of livestock, the distribution of livestock, the kind which would be cheaper cows and the season of use.

And those four things are what come together and should come together in range management.

Now holistic management, oftentimes, gets tied up in short duration grazing and things like that.

I won't use that term.

I will use the term "adaptive management." The concept that based on what's happening, you adapt to.

The way we live the rest of our lives.

So here's my take on this.

We have already talked about the season of use, winter grazing can run anywhere from late November through May, and we still call it winter grazing, although we have actually gone through three of the calendar seasons.

We talk about the fact that for the maximum benefit of crust, the likelihood that they are going to recover from anything, it just happened to them we need about a month of soil moisture before it starts turning dry.

And so you guys have no doubt hear on average year more than what that is.

So let's take that concept.

If you are grazing in a continuous use pastor, the continuous use, it means that you went into that pasture, whatever day it was that you allowed to graze.

You stayed in that same pasture to the last day you were allowed to graze.

That's continuous use through that period of time.

If that continuous use exceeds and it doesn't take into account the month of moisture that you need or the biological soil crust to do as well as they can, while there's still moisture in the soil, then there's not going to be any recovery and there could be damage and that's the nature of the site, because you -- before you finally go off the soil is dry and there will be no recovery.

And maybe you are going to get monsoon rains.

That's going to be a big help.

But it would be better if, in fact, they didn't have to go through that crushed up stage, dry stage and hope for a monsoonal storm.

So my thought on this, but you it I will have to have -- if you are going to graze livestock, if you are grazing now from December 1st to May 1st, then you still got to have some place to put them.

You know, they don't just go away.

You know, February 15th, use that as the magic date.
They don't go away from February 15th to May 1st.
The only thought I can come up with is to put together rotations where, in fact, you would, in fact, graze as we describe from December 1st to February 15th.
At the same time you are grazing that part of the pasture, or pastures, this over here is not being grazed.
And you move in and the next year you reverse the time.
You go here first and here second.
Now, that means that when you go on to the second pasture, you are probably going to be grazing from February 15th to May 1st.
And what's absolutely the worst time for the crust.
And so over a two-year period of time, you are averaging it out.
You are making the assumption that that's better than grazing it every year from December 10th to -- or to December 1st to May 1st.
So something like that is based on the information as I know about crust and I'm not a crust guy.
I'm not.
>> DR. ANDERSON: You're not crusty?
>> DR. BUSBY: I'm crusty but I'm not a soil crust guy how you balance the stuff out, that's the way it would have to be done.
Now, the rest of the rotation grazing concept has that early season, followed by the late season, and it has the third year which is the season of rest.
Rest means you don't graze it for any -- at all during that year that it's supposed to be resting.
And that would, in fact, then give that -- the crust that particular year the full advantage.
So it would basically be the year you are in early and then get off is an advantage to the crust for recovery, the year you are not on at all gives it -- the crust an opportunity for recovery.
And the year that you graze it late, you are -- you are going to hurt the crust as I understand.
You are certainly not going to benefit.
And so those are the kinds of things that you have to think about.
It's not the number of animals.
It is the timing.
I think timing has been underestimated as an important factor in range manage.
For most of my career and I think we are finally beginning to understand it a little bit better.
And timing is set by what your objective is.
If you want to graze to do benefit crust, then that's the objective and you look at that month long period of time where they still have water.
So the next thing is, getting back to Matt's comment about some kind of a thought process in this EIS about where are the areas that have potential for crust and without crust they are very susceptible to degradation.
You know, they are going to wash away or blow away.
Those are the areas that you may never want to graze those after February.
Maybe those are the areas that want to do everything you can to encourage the development of a -- as much crust as you can get.
But still graze it during that early period.

And so if you have that kind of a situation, where you've got -- you've got it zoned, where this is where you are going to use it, then you've got to have some other place that's zoned, that you say, they are not as high a potential and even if it's a crust or weakened or disturbed, it's not going to be anywhere nearly susceptible to damage.
That's where we go late.
So that's really simple it seemed like, until you basically say, well, all of those areas tend to have high potential and in the northern part of this, monument and we have to graze those early and get off by February 15th and all the areas we use before are down here in the south and we can graze those after February 15th.
That's not where your ranchers are or your livestock are.
You will have to work within allotments.
You will not be moving people around allotments but I think you have to look at the dates, the pending allotments and I'm not a big proponent of additional fencing.
For a lot of monument, I don't think you have the -- basically it's live streams, or other sources of water.
You don't have the opportunity to turn off and on a windmill to basically say, well, we will shut this off and they will have to move down there.
It's -- it's difficult.
First thing, probably, really quite frankly, the first thing is to figure out the answer to Matt's question is where you need them because the site is so susceptible to damage without them.
Once you figure that out, and I have no earthly idea what amount of monument that is.
Once you've got that figured out, then figuring out how you can graze the rest of it in a way that works to everybody's advantage, is our job as range managers, to do that.
So those are -- gosh, those are not very specific answers but they are the best I can do.
Now, the second part of that question was how can it benefit -- what are the benefits?
What are the risks?
You prioritized and you made some decisions about what you need to do.
The risk are -- our biggest risk is climate and that's where I want to lead to reuse the phrase adaptive management.
We need -- when we start -- when we feel -- when we feel like that we are way below the normal average precipitation that we should have received in the winter, then both ranchers and the BLM ought to be thinking about how they will make adjustments.
I mean, it's your -- I mean, it's your cows, out of forage.
It's your loss of production to go out on the range that has no potential for production.
And just, you know, it's -- it's space.
It's a place to store 'em, but that sure doesn't make you much money.
So somehow or another, is that -- those conditions occur, be prepared, be willing to adapt to them and figure out what adjustments can be made.
And the wet years, yeah.
You have abundant forage, figure out how to take advantage of it.
>> KATHIE LIBBY: Other panelists?
>> DR. ANDERSON: I came up with some of the same concerns and issues that Fee did.
I don't see you can do anything that at least some point during the year, you are going to have an impact on the crust.

The other option is to create a tremendous infrastructure through fences and all of that, and that's just not feasible to do.
So I think no matter what, however there is going to be some, you know, impacts and trampling and things of the crust.
>> DR. BUSBY: Let me do one more thing and then go to Jayne.
I talked about range land improvements this morning.
I'm a guy that believes, in fact, there are ways to manipulate this range land to, in fact, benefit everything.
I talked about it in the concept of biodiversity.
So you've got this big sagebrush flat out area east of town.
I suspect every single person is wear of that country that basically lies out there to the east and just goes down the hill, down the slope.
The sagebrush and for thousands and thousands of acres, not very much grass, except, again, under the sagebrush.
So you have got a rancher would has his allotment out this, and he has his numbers and his animals are out there struggling to find the forage necessary to survive in that condition.
And if there is a plant, or a biological crust that manages to stick its head up above the surface, they are out there in the inner space between those sagebrush plants, it's likely to get harvested.
So the issue, to me, is that sagebrush is thicker than I think it used to be.
I don't think it's burned in a long time.
And I think Native Americans probably used to burn it.
Lightning used to burn it because this was grass understorey with it to provide fine fuels.
We have to replicate that if we want to begin to approach that reference state of what the conditions are possible.
And so knocking back that sagebrush and increasing the amount of forage that you have, to me is just -- it's something that is a piece of the puzzle, call it forage or biodiversity, I don't care which, it's the same thing.
And now, you -- if you've got a grazing system, you've got cows that have a choice and then you are moving them in a way that basically says, all right, this year they are going to be able to take blue bunch sweet grass and they are going to be able to clip it off when it elevates its growth point.
Next year they are not because they are not going to be there then.
And that blue bunch will be able to complete its growth, and so you just -- but you've got to -- you've got to have the blue bunch there before you have those kind of choices.
And so I think judicious range land improvements are a piece of this puzzle that we cannot overlook.
>> DR. BELNAP: So he made me think of one thing, and then I will go back to what I was originally going to say.
One of the biggest reasons from a soil crust viewpoint to reduce numbers on allotment during drought.
When you have less forage, you have more walking.
And when you have more walking, you have more trampling and also the cows are losing weigh because they are wandering around looking for more and more to eat.

And from the soil crust, doubt is another reason when it's careful about the number of animals out there.
What I wanted to take on, because I'm assuming this question is really aimed at the holistic management put forth.
I'm an adamant opponent of that in the low precipitation zones.
I have to do full disclosure.
It seems to work very well where it rains more.
A lot of people are successfully using it there, but I am having real heartburn not just from a soil crust viewpoint, but from a lot of different viewpoints especially a soil erosion viewpoint and every place that I have seen in the lower precipitation zones and it's not just a matter of that massive infrastructure that's needed but it's basically the idea is that one, soil crusts are bad and that's stated pretty clearly in the manuals on, that there's something you want to get rid of, and I, as you note, I don't like that idea.
And, two, the idea is that you really, really, really use the pasture that you are in before you go to the next one.
That I have a hard time with because there's every reason to not utilize something that much.
The their and Fee alluded to this, where I have really seen this used a lot, is bases that have highly variable precipitation, and that's desert, where you have, you know, you have years where you have a lot of rain and years where don't have a lot of rain.
The question is:
What do you do with the animal when it didn't rain that year?
Because in the manual, it says do not put the animals back on a pasture until the grass is at a certain height.
Well, what if it didn't rain?
Because if it didn't rain, those plants aren't going to be at a aren't going to be at a certain height to put the animals back on.
I never had anyone satisfactorily answer this for me and I think the risks are huge and those risks are soil erosion.
You have a lot of hooves out there, pushing the season.
Yes, certain time of year that works but there are other times of year that the seeds aren't there.
And yet you have trampled the surface and it's highly exposed to erosion, drain rainstorms in between the times when those level of animals might be useful and I work a lot in Kenya where -- and other parts of Africa where the basic idea is literally, the more animals, the better.
And, you know, seeing 10,000 animals on tiny being tiny allotments go for it.
I'm just -- there's to way to handle that kind of use and not erode the soils.
It's just not possible.
And so it's that variability.
It's when you are in areas where you have highly variable rainfall that I think the benefits are much smaller than whatever -- I should say, the risks are so much bigger than any benefit that may be taken advantage of, that I get really worried on and I have not seen any success that doesn't have this long-term cost.
I have seen short term benefits but I haven't gained avoidance of the long-term costs.

And there are literally hundreds of studies on ranches that have used this to show that long-term cost of soil erosion.
And it's huge that cost.
Again, we are not talking about areas where it rains more.
It's been very successful in areas where it rains more.
I'm talking about these lower precip zones like what is the lower elevation here, not the higher elevation but the lower elevations here and it's really not been anything that I would advocate to be used.
And that's independent of all the fencing and all the costs that come with it.
So that would be my personal opinion.
>> DR. BOWKER: May I add a little bit?
One more thing about the high intensity vocational grazing is the theory underlying it is that there's something missing from the ecosystem that you can provide back and it's meant to simulate large herds of animals that were mobile on the landscape.
But we just heard a little while ago that there's no evidence that there were large herds of animals.
So what are we -- what would we be simulating if we did that?
It would be a new type of stress for this ecosystem.
So I would be afraid of it.
And also, I'm, you know, being a scientist, I decide what I believe in based on evidence, and if you are going to make extraordinary claims about something that goes against conventional wisdom, you need extraordinary evidence that it works and I don't see it, and anything that has convinced me personally or in the science journal.
I would say, be cautious with that.
I'm afraid of it.
If somebody tries it, I would suggest you try it on some kind of a small scale experiment first and learn from that before you turn the whole allotment into that system, provided you can afford all the fencing, et cetera.
Maybe it's a moot point after all.
>> DR. BUSBY: So now let me speak in favor of saving it.
Allen Savory moved here in from South Africa in the 1970s, Bill.
He's known for two things.
One is the short duration, really short duration, high intensity grazing that Jayne and Matt talked about.
Lots of animal, for a very short period of time.
So that's -- we are all in agreement on that in this area.
But holistic resource management, holistic means the whole, and so when Savory basically has talked about managing the whole, he is much more on the right track of how you have to think about all of these pieces of the puzzle.
And so don't discount the word holistic resource management just because it -- the same person is tied to the grazing system.
So think about the monument as a whole, in a holistic manner.
That's not -- that's good.
But the grazing system, we don't think is what you want to do.

So -- and we always have to make sure that there's a differentiation between those two concepts, holistic resource management and short duration, high intensity grazing.
>> DR. BELNAP: And I have to add to, that because I absolutely agree with Fee.
There are a lot of tribes I work with in Africa and there's a group of -- a nongovernmental organization, that's organized a lot of these communicates that are very big proponents of holistic management and the head of this organization said, we don't care about the grazing part.
The reason we are selling this to these communities is we are looking at what they are doing.
We are getting them to understand these different ways of treating the land, have different impacts and they need to understand what those impacts are, but if they don't even look at it, they are never going to get there.
And so there really is a way.
They have done the same thing of decoupling the actual grazing system ideas that what you have as a whole and you need to come up with the best treatment of that landscape.
And so from that viewpoint, absolutely.
It's just the high intensity part that really makes me nervous.
>> KATHIE LIBBY: Okay.
We actually -- so I would like to give us a 10-minute break, but not just this second.
I would like to squeeze in a few pieces.
We are moving into how do we adapt to climate change.
Let me read a couple of questions to you and you can pick up on any version of them that you would like.
They are similar.
One is where do you see GSENM in terms of desertification, or worldwide desertification.
If the Colorado plateau climate becomes more like the Mojave Desert, what changes would you predict?
>> DR. BELNAP: Hey, the Mojave is a pretty -- yeah.
>> KATHIE LIBBY: And the third, these are all related.
Not that you can predict, but with your understanding of climate change scenario for the monument, would there be a dust bowl here with darkened skies and gigantic drifts of wind, blowing sandstorms and dust?
>> DR. BELNAP: Do we randomly pick at these?
>> I have to go!
>> DR. BELNAP: Let's see, the last one was no.
The middle one was already happening, you wouldn't see a big dust bowl.
No, other plants will move in instead.
I mean, not all.
The second one is it's already happening.
We are seeing some lichen species fading out and others moving in.
As they move northward and I got the first one.
>> KATHIE LIBBY: The first one is where would you see the monument on the worldwide scale of desertification.
>> DR. BOWKER: Yes, desertification, that's a difficult subject, because it means different things to different people.

It's when it acts like a drier environment.
In China, desertification means sand encroachment.
In some places people think of it meaning as shrub encroachment.
Erosion is a common symptom but it would not be always part of it.
But to get to the gelatinous, how is GSENM, it's totally variable.
Some places are eroding and it looks pretty bad but it's not as bad as many maces in the world that are completely denuded of vegetation.
I don't think America or at least the United States really experiences the degree of desertification that you might see in places that have been over utilized for millennia.
You know?
>> KATHIE LIBBY: So if this was a definitive scale, we wouldn't be at the top of it?
>> DR. BUSBY: We are denying there's a definitive scale.
>> KATHIE LIBBY: That's what I'm hearing.
Okay.
So one more just before we go back to our formal questions.
Following drought, is it really wise to then use regrowth when moisture returns?
Do crusts or plants need time to recover after a drought?
>> DR. BUSBY: During a drought, your plants are in stress.
They try, and that means they put up a few leaves and they photosynthesize until they run out of moisture.
If that moisture lasts long enough, that they, in fact, can put up enough leaves and photosynthesize enough to take care of the -- to basically restore the buds and the root system, then it's been a successful year.
It hasn't been a very profitable year but it's been a year that they are going to perpetuate themselves.
Multiyear droughts, tend to cause plants to slowly contract because more and more of it is not able to survive.
It would -- it would be best, let's say a spring drought, you have gone through several years of spring droughts and so you have the cool season plants under real stress.
It would be far better the first year following good moisture to not graze them until they are dormant.
Let them have that full green growth period to reestablish, to go to do some seed, do everything they can to recover and then take the dormant vegetation that we talked about earlier today.
That would be the ideal for the plant.
It wouldn't be the ideal -- it may not be the ideal for the ranching industry but it's ideal for the plant to basically give that recovery.
When we recede a range, when we plant seed on it, we oftentimes give at least one, if not two years of rest for those plants to become well established before we go in and begin grazing.
And so that's starting from scratch and a drought -- coming out of a drought is a little bit better than starting from scratch but maybe not much.
So you are -- you are to provide some opportunity for the plants to recover before you begin to graze.
>> DR. ANDERSON: Speaking to the lichen of the cryptogamic soil.

You know lichens have evolved with the drought.
Lichen specimens maintained under herbarium, you can take them out every so often and water them and you can keep lichens alive in the herbarium for a long time.
Once they get rewetted, it does take, you know, a few hours and then they will start, you know, doing their full photosynthesizing thing.
So I don't know -- you know, I'm not speaking to the light or the cyanobacteria, but at leach with the lichens they don't need a lot of recovery time, and then they are back doing what they need to do.
>> KATHIE LIBBY: Okay.
>> DR. BOWKER: I think the stress is with drought and crusts come in, in that period of inactivity.
They are degrading their life and losing photosynthetic pigment.
The other thing that happens during a drought is if soil is eroding and blowing around in the wind, the crusts are getting buried.
I saw this a lot personally across the monument in 2002, where there would be little pinnacles poking out of newly deposited sand.
And if they are underneath there, and then they get rehydrated, to really live, they've got to wiggle their way all the way up to the surface and that may be far too far for them to go.
>> KATHIE LIBBY: Okay.
So I will throw out the last question before our break. under management options.
What management practices -- oh, this is an easy one, Fee.
(Laughter)
What management practices can we adopt to help the BLM to respond to year-to-year conditions and long-term climate change or drought.
>> DR. BELNAP: That's easy because you already answered it.
>> DR. BUSBY: Well, yeah.
Adapt to what is.
You know, don't -- you've got an allotment.
You've got 500 animal units and these months and this grazing season.
Works most years.
Wet year, maybe you take advantage of more forage.
Maybe you stay longer.
You can do that in two or three years, you increase the number of animals and you can stay longer.
The amount of feed and then feed one animal.
If you stay an additional month, it's like -- it's basically feeding that animal.
You've got a good wet year, you can take advantage of it by adjusting like that.
You've got a dry year, again, the -- the first thing to do, if I was a rancher, I would call the dry cows, the old cows, and I would begin to reduce numbers like that.
And if I was -- and I would begin to, you know, the issue -- the issue is you've got to have them somewhere.
And so cutting the season back is a real problem because that means that what season you took away, those animals have to suddenly go somewhere else.
They don't hang in the air by a balloon.

They have got to go somewhere.
There are so few resources available that can be leased or hay balled or whatever.
They are few and they are expensive.
So adjusting the numbers to get rid of the less productive animals and just keep that contraction as long as the -- as long as the drought is in, you just have to keep working in that.
I mean, that's what people recommend.
Basically, begin that process of -- of culling to get rid of the less productive animals and begin to -- to selectively pick which animals you want in the herd when it rains again.
Now, was that the question?
That was the answer.
>> DR. BOETTINGER: I would like to add keep in mind the big picture because while you may have a wet year, you may be still in a larger drought cycle.
And so, it may not be wise to go full bore, I've got a wet year and I have to get a bunch more animals out there.
It could be that it's going to be dry again the next year and the year after that, and the year after that.
So think in moderation.
What are some of the longer term cycles and I -- I really would like to put a plug in for the Utah climate center, that's up at Utah state university, they are really starting to get a handle on what's driving the longer term drought cycles.
And as more of that information becomes available, I suggest, you know, you really take that into consideration for your longer term planning horizon.
>> DR. BELNAP: I wanted to emphasize what Janis just said, we know now that we didn't know very long ago, that there are these 20 to 30-year cycles of wet years and dry years and we really can predict now pretty accurately in the fall whether or not the next spring and summer are going to be wet or dry.
I mean, we know a lot now that is out in the future.
So it really gives us the opportunity to plan like we haven't had ever before.
And so, yes, we really need to start taking advantage of the meteorological advances that we have, so that we can start doing drought predictions and every other prediction that we are interested in.
>> KATHIE LIBBY: So thank you for the last five minutes particularly represented, as I listened anyway, what a collaborative solution this needs to be.
This is not just about what BLM is going to do.
This is what every interested and affected party is going to do.
Yeah.
Very interesting.
Thank you so much.
I'm going to suggest we take ten minutes.
Be back and ready by 2:30 at which point, just a quick point, the next session is what else don't we know?
We are going to talk about things we still need to research.
I will reduce that to 45 minutes and we are going to open up the room for your questions for a half an hour before we close.

So if you have given me and some in handwriting, you may want to go ahead and speak those into the mic yourself.
Thank you.
See you at 2:30.
(Break)
>> KATHIE LIBBY: We are getting ready.
We are getting ready.
We are all getting ready.
We are getting ready.
>> We are all getting ready.
>> KATHIE LIBBY: Thank you, sir.
We are getting ready to start.
Oh, my!
Who did this?
Okay, gentlemen, thank you so much.
>> We wanted to look good!
>> KATHIE LIBBY: Yeah, we are on camera.
Okay.
Welcome back officially, everyone.
And I do understand that we had no Internet interruptions for the first half of this afternoon.
So we're happy about that for those of you who are participating online.
Just before we get into the third panel discussion, I have two questions I'm going to raise.
Is there any way of reducing sagebrush with minimum impact on soil and crust?
And the answer is it depends.
>> DR. BELNAP: The answer is?
>> DR. ANDERSON: Spike it.
Herbicide.
Herbicide.
>> DR. BUSBY: The soil applied chemical and by the amount you apply, you affect the amount of control.
So it works pretty well.
The second one, if you are going to see, I like Bill Hobson's law scenario.
It's a great big rolling drum -- sorry -- it's a great big rolling drum.
It has metal on it and so as it rolls into the soil it, basically can cut off branch of sagebrush and then it will leave a little pit.
You seed in front of it and some of the seed then are planted as the aerator rolls across it.
Bill has used it a lot at the desert.
And I think it's a relatively good tool.
It's not as acre effective as spike or herbicide or the Healey chain.
What is it 20-foot across, Bill?
12 to -- okay.
I think it's a lot of passes but you can take a pass and skip over 40 feet and take another pass.
So you can create a mosaic.
You can do that with spike as well, simply the way you apply it.

If you are going to seed, then that aerator, to me is a tool worth looking at.
>> KATHIE LIBBY: Okay.
Thank you.
The next one, not that I'm not fascinating by all of your questions but I really like this one.
(Laughter)
And answer.
Is it the role of the monument range com or role of the ranchers to adapt the management?
>> DR. BELNAP: Both.
>> DR. ANDERSON: Both.
They should work together on that.
>> KATHIE LIBBY: To go and individually both responsible for adaptive management.
Yeah.
Thank you.
Okay.
So again, we will at 3:15 just open up the room for questions.
In the meantime, what else do we need to know in the panelists are going to discuss additional research questions.
And a couple of things have come up during the day.
So --
>> DR. BUSBY: It's too late for this one.
We really need to figure out how to get these EISs done at a reasonable decent period of time.
(Laughter)
Yeah, sorry, guys.
Correct me if I'm wrong, the grazing AIS was pulled out of the original monument planning AIS because it was too controversial.
So they did the rangeland health study in 1998 to 2002; is that right?
Is that pretty close to the dates?
Just to speak on rangeland health, they did either 550 or 750 points, randomly located around the monument with some stratification because some areas were considered to be more important than another.
Each of those areas, they looked at 18 indicators.
On this one they looked -- the 18th was the biological crust.
And that is -- even though it's ten years old, that is, to me, it's still an amazingly important source of information for this monument.
It's not been very many BLM lands that are so uniformly covered in soil.
And I know an analysis of that, there were areas that were rated very high, no problems with most of the indicators or the three attributes for enzyme health, which is soil stability and body integrity.
And then there were other clusters that routinely rated low and I don't know that we have done the management because the last EIS.
I don't know what was done in the rangeland health study.
I hope it's something that's being used in this current EIS situation.
Anyway, following that, there's was a grazing EIS done.
And it was submitted in draft form and was sent to Washington, D.C., where it died.

And so we're doing it again.
And so I'm really kind of serious that we ought to -- you know, we need to figure out something about this process that maintains its effectiveness in terms of the method of doing planning and decision making but also something that can actually get done.
And so this one turns out to work.
I look at the BLMers in the back row, I really hope this one works.
I really -- I really hope this one works!
>> DR. ANDERSON: Touchdown!
>> DR. BUSBY: Or as they say in soccer, scoooooore!
>> KATHIE LIBBY: Do you have some more?
>> DR. BUSBY: No, that whole process, the interaction of the interested parties communicating, respecting each other, sharing, figuring out how to do that, I don't know that that's a research project, but man, that's the answer to the question.
Now I'm going home.
>> DR. BELNAP: Okay.
Now go home.
No, don't go home.
I have actually a short list here of things that I think are really essential for the soil crust to be incorporated in this planning and we have talked about all of them so I'm recapping what I think is the real critical one.
One is coming up with this map of where the crust potential is high and the services they provide are high.
And finding those areas where we need to look at the vulnerability of those sites to any sort of degradation depending on, you know, what it is that the driver of that word -- bad word.
Never mind.
The driver of things going downhill.
I won't use that word, the g word.
I think that's probably number one for the planning effort, is that we really need to identify these efforts where the services are the grayest and they are the most vulnerable to being destroyed or compromised.
Second is exposures.
It's really hard to manage effectively if you don't have disclosures in the different vegetation, types on the different soils at different climates and big ones, not teeny, tiny one because you get too much edge effect.
Really, that's not going to help this effort, but for all future efforts, it's going to be really hard to make management decisions without having something to refer to.
And then thresholds, we talked about this.
This gets to the question of how much crust do we need.
It's a pressing research issue.
We don't want to cross the thresholds and the thresholds that I identified are the erosion resistance.
We don't want to push the crust down to a point where they are at that really vulnerable state.
We want to have them above that.

We want to have a minimal -- a minimum nitrogen input defined and we don't want to push them below that.
For hydrology, we want the bumpiness for increasing the residence's time of the water so we have time to soak in and not just run off.
It's a minimum amount.
We want to roughen that surface.
That's really important and we don't want to push them so far back that we don't have any bumpiness to our surface.
And composition.
This is interesting.
I had awe graduate student who did a stud in Mexico and another one in Spain, and it turned out if you pushed down the composition and it tushed down so far that all you were left was cyanobacteria and then the system was left to recover, you didn't always end up at the same endpoint as you used to.
Sometimes the whole composition just went...
Errr!
And unfortunately for those two studies, we lost a lot of nitrogen fixtures we ended up with a system where there was nowhere near the nitrogen that used to go Ma that system.
I would take a look at how far back that sequence are we pushing them and not go that far back and go, whoa, wait a minute.
Nitrogen inputs are important.
We don't want to lose as Fee was saying, the seed for recovery.
We don't want to lose everything.
We want to keep it up close to that, but these are all research questions, in essence, because we need to understand a little bit about where that threshold is.
And then lastly is a question that just came up, I think we really need to look carefully at vegetation treatments, how do we do them in a way to disrupt the surface soil the least.
We are talking about the soil structure that allows for water to infiltrate.
We are talking about the bugs in the soil.
I think that's a big question that normally we go in and we do what we always do, instead of asking the question, how do we bring in a new management goal and that is to have soil surface disturbance be minimal.
I think that's a new way of thinking of this and that would be at research -- you know research in quotation marks.
How do you think about a system to keep that soil system intact?
That's my list.
And that should be done in five minutes or less.
>> DR. BOWKER: Not so much for the grazing EIS.
I think these are great for the task at hand but in terms of, you know, building up a body of knowledge, about how crusts work and the role in the environment, and how we manage crust, I think one pressing thing is to find out to what degree we can actively restore crusts, grow them and then put them back out to the environment.
And how big can we go?
So that's really important and that could be a really useful tool in our back pockets going into

the future because there may be places where despite our best efforts or sound management decisions, ecosystems are still in bad shape and they might need a different kind of intervention.
We talked a lot earlier about crust and plants and how they interact.
I think it would just be really cool to do -- to design and implement the best crust plant study ever done in Grand Staircase-Escalante and to do that, what you would need to do is you would need to focus on multiple plants, multiple native species.
Would you probably also want to look at multiple problem weed species.
And you want to track how different kinds of trust influence the success of those plants and by different kinds, I mean all of these different groups we're talking about, cyanobacteria crusts, moss crusts, lichen crusts, because the answer will be different depending on the kind of crust and depending on the plant species.
I think you need to lock at this on multiple soil types and you need to look at this in multiple climates.
And finally, you need to not just look at one aspect of the crust plant interaction, not just a germination part of the study.
You want to look how they germinate, and do they reproduce on different types of soil?
And I think this was a great natural laboratory to learn that and that would be a great piece of knowledge or great chunk of knowledge going forward.
Other than that, I think other folks have hit all of my ideas.
I second the idea of a system of reference areas that are -- that aren't currently grazed.
It just helps with management.
If you are going to -- if you are going to try to assess the health of a place, you need to compare it to something.
And if you set aside some areas that are not seeing repeated use, that might be one thing that you can compare it to.
And I agree with Jayne, it needs to be a fairly comprehensive system.
>> DR. BELNAP: One of the really powerful things of those is the biggest challenge I can see for the land managers in the future is separating out the effects of all these regional things from land use at the spot.
You've got nitrogen deposition that's increasing and CO2 that's increasing and temperatures that are increasing and those are things you have no control over.
And so, you know, we've got to have tools to sort out those things from what the different land use is doing so that you can really understand how to change the land management or not, because maybe what you are doing has nothing to do with why you see the changes you see.
>> DR. BOETTINGER: What I would like to see is a way to help sort out, as Jayne just mentioned, some of the factors that can confuse our understanding of the distribution crust and the soil crusts that are on the landscape.
I was just telling Al over the break that we worked recently in Canyonlands National Park to predict the level development.
Can I show that one slide?
I know I -- the level of development of the biological soil crust.
There was a soil survey update at Canyonlands National Park, which has had no grazing for

about the last 50 years.
We took over 600 observations that the soil survey crew collected of the soil sites and the level of crust development.
We found that the best predictor of the level of development of the crust and, yes, we can go more into mosses and lichen but when you have a soil survey, we wanted to have something that everyone felt comfortable describing.
So we did the level of development.
It's okay if you can't do it.
So soil map on unit, that was the best predictor.
The next best were lands the remote sensing band ratios and then also elevation and solar radiation.
Great.
We can predict this in part, what can we do it?
We took that information and predicted outside of the park on BLM land that did not have that very good soil survey and we were able to predict with internal accuracy assessments potential crusts which we had 11 exposures to us outside the park and we 100% were able to predict the level of development inside the exclosures.
What did it look like outside of the exclosures?
It had a much less level of development of the crust.
>> Which one do you want?
The.
>> DR. BOETTINGER: It's the picture I sent Kevin.
I think it was early on, number five, slide number five, I think.
So this is what the soil survey crew used in Canyonlands National Park when they were out describing soils.
There also was a class zero, where there was no evidence of a crust.
They broke a piece off and they didn't see any film and so there were seven classes.
And class one would have just a barely stabilized with a light cyanobacteria crust.
Increasing amount of cyanobacteria crust from one, two, and three.
Class four you start to get more of the dark cyanobacteria.
Some mosses.
When you get to five here, you had a good cover of mosses as well as dark cyanobacteria and then when you got to class 6, you had a good population of lichen that were here.
So those were the level of development classes that really anyone who has the reference sheet with them go out and make an independent evaluation at that site.
By predicting outside the crust and having available -- outside the park, excuse me and having available the exclosures, we were able to validate our predictions as well as realize something has been happening outside of those exclosures that took us away from that potential level of development from inside the park.
I think the data set that Matt has worked on for his various degrees here in the park, the data set that Mark Miller has, can be refined, I think, and we can do really a -- to revisit and do a better job in incorporating remote sensing bands that get at parent material, the different geologic units, incorporating some other data layers that might get at climate and help us sort out what would the potential crust cover in terms of the data that you have.

Look inside the monument, and if we could set up a series of exclosures.
Look how long it's been since the monument has been declared.
18 years.
If we started 18 years ago, putting exclosures, we would be far on our way to looking at what 18 years of rest from significant land use impacts would be.
So I say start now, if we can, on an exclosure system.
>> DR. BELNAP: Hear, hear!
>> DR. ANDERSON: My understanding is when this monument was created, it was supposed to be a science outdoor laboratory.
And it doesn't seem like a lot of that is going on right now.
And I don't know whether it's fear, trepidation or what, but there are numerous -- we have heard all sorts of examples of things that could be done, research, down here on the monument.
I don't know if it's fear of disturbing the soil or what it is.
I know that the -- the plan itself kind of ties the monument manager's hands and what can be done and what can't be done.
And so some of these things may have to -- there may be a need for an amendment to the plan.
So some of these other research opportunities can be explored.
But listening, you know, the -- the things that have been identified for research are all good.
I like what Fee said about the nutrient requirements for crested wheat grass or the nitrogen requirements and we could expand that into looking at Indian rice grass and some of the other native things that are occurring here at the moment.
The -- you know, I've got the -- I showed a slide earlier of the sagebrush mortality.
Half the sagebrush on that site were dead.
Why?
I love that.
That would be a good something to explore and understand why we're getting that.
So that, you know, the perception of a lot of people that don't -- that aren't in research positions and doing all of this stuff, is that it's the sagebrush, but it's the cryptogamic soil that's killing the sagebrush.
We are hearing that may not be.
Look at that list.
There's a lot of sagebrush death on the monument.
Let's figure out what it is and what is actually causing it and we can maybe come up with an antidote for it to keep it from dying.
The other thing that the monument plan talks about a lot is adaptive management.
And I think adaptive management requires some action on the ground.
And, again, it seems like in the past, there's been some hesitancy on the part of management to do anything that might be controversial, but we can understand what's going on on the monument without doing some of these things and applying adaptive management into the whole process.
That's my whole thoughts on the doing the research here.

>> DR. BUSBY: I would add just one other thing that was brought up.
In talking at lunch it was said there were no sagebrush areas on this monument that weren't grazed.
We didn't get to actually finish that discussion.
But the question is: are all the sagebrush areas in allotments?
My guess the answer to that question is "yes."
So the next question is: are there areas in those allotments that are sagebrush allotments where there is no water, that there's almost no grazing in corners of pastures or distances away from water?
And so those are areas that can kind of provide a reference either without the exclosure at this moment.
The other piece of the puzzle, as I remember the rangeland health results, there were using the semi-loam desert sagebrush sites which is fairly common across the sites.
A lot of those semidesert loam sites had very low rankings in all three of the attributes, soil sort stability, hydrologic function, and biotic integrity.
So one of the questions would be to look at the semidesert loam sites and fine if there were any of those rangeland health points that were taken on areas that did not have low ratings.
In other words, were stable, had good function, and were judged to have high biotic integrity.
Reference.
So the data -- a lot of that data is there to basically give you some idea of what some of these potential conditions might be but you're going to have to look through those rangeland health assessments and find those points and then go -- probably go look at them again.
But there is a wealth of information that I think can really inform what you're challenged with.
>> KATHIE LIBBY: Okay.
You can have more to say, but it's been a very long, intense day, and they're still listening very intently.
We have a question for you.
Uh-oh.
Exactly which provision, which provisions, in the monument management plan, quote, tie the manager's hands, unquote, so they can't do research.
>> DR. ANDERSON: As far as doing research there is nothing that ties their hands.
It's management of the itself.
There's too much contradiction within the plan.
You can do this, but you can't do this.
I don't have any specific -- I don't have the plan right in front of me.
I could give you some specifics.
But there -- and those that are on the monument that are familiar with the plan know that there are contradictions within the plan, and I think those are the kind of items that tie doing any aggressive-type management.
The research part of it, there's nothing that ties the manager's hands from doing the research.
It ties their hands from cracking eggs to make an omelet.
>> KATHIE LIBBY: And another research relate one, is there --: is there a research need to assess different grazing management approaches and their effects on biological soil crust?

>> Yes.
>> Yes.
>> DR. BOWKER: That would be a great thing to do [inaudible]
>> KATHIE LIBBY: [inaudible] so there were a number of other questions that we didn't get to specifically, but I really do want to open it up -- you have been listening so well today, and I would like to open it up to your voices, literally.
So even though you gave me one of these, if you haven't heard it yet, I'm going to invite you to express it yourself.
I might catch a few.
Some of them we may have bypassed and you've moved on and whatever.
So, open mic.
Yes, sir?
>> Participant: Earlier today it was said that -- I think it came from a question that you were asked, Jayne, during the break, do you think we should manage for crust.
And your answer was, no, we need to manage for the services they provide.
So I guess circling back to that, if vascular plants are capable of providing services like soil stability and nutrient cycling, does that -- or how does that diminish the need to restore biological soil crusts?
>> DR. BELNAP: Let me use a specific example where I have so much vascular plant cover, I.E., when I go up in elevation and I'm getting into almost continuous plant cover, then that's not something -- that's not a component of the system I'm going to think very hard about.
I've got a lot of other issues to think about.
So it's really that balance of where you're getting down into landscapes where you don't have the plant cover, you don't have -- you've got these large interspaces between the plants, and so you need those services provided by something else other than the plants.
But the short answer is that when I get up in elevation, or like along a riparian area where you've got big tall trees and it's really thick in there, I'm not going to be thinking soil crust as a concern.
I'm going to be saving my energy and concerns for when I get out to where it's really important that they be there.
Did that answer your question?
Okay.
Great.
>> DR. BUSBY: In one of Neil West's publication he actually had a drawing in the semidesert shrub, or semidesert sagebrush would be the example of where you have almost always between sagebrush plants and grass plants an interspace, simply because the plants are rooting into that interface and getting at least part of their moisture and their nutrients.
If there's not enough moisture in a system to provide that continuous cover, that's where these crusts are seemingly the only critter than can live out there and provide that protection.
As you get into the upland sites, you've got enough moisture and you begin to get that continuous cover.
As you go up in higher elevation, more moisture, it gets even more continuous.
So I thought Neil's diagram really explained what we're trying to deal with and the role of crust in providing that cover that vascular plants can't.

>> KATHIE LIBBY: Who else?
Okay.
So I'm going to read the next one.
Would each member of the panel please comment on the profitability of grazing on GSENM, taking into account trends in drought, needs for short rotation, cost of fuel and alternative food sources, arid conditions at middle and low elevation and requirements to restore the landscape.
If BLM wants to manage for the restoration of crust, how greatly -- allotment use need to be reduced?
The profitability on GSENM with respect to all those considerations mentioned.
>> DR. BOETTINGER: I don't have a clue.
Hub you guys just heard a report three weeks ago from people who did a social economic study.
So somebody in this room that was at that meeting would be better able to answer that question than any of us can, and quite frankly, some of you ranchers that are out there doing it would be better at answering it than me, and I suspect the rest of us.
So what did you learn from the social economic study?
I know, Randall, you talked about it last week at range camp.
So I know you were here to hear it.
Not to put any pressure on you, of course.
[chuckling]
Jim?
>> Participant: The work that's being referred to was done by Dr. Gill Miller and both counties of Cane and Garfield.
He took a look at the gross product for both counties as well as the value of the grazing from an AUM standpoint.
Right now it's running at about $125 an AUM.
So it has a significant value when you look at it in that fashion.
Additionally, it used the M plan model, which had multipliers compared to the other multipliers that were out there, and on that basis, if you have a combined gross product of nearly $400 million, it represents about $32 million.
So when you look at the sum of the parts, it makes a significant contribution.
It's a real value.
That's not intended to say that one or the other needs to be discontinued.
It just says how does it all add up, and it adds up, and we're very aware of that.
>> And this is Cane and --
>> Gar peeled.
Copies are available.
>> DR. BELNAP: Are they?
Could you tell me how you find it, the copy?
I would love to read this.
>> Participant: I don't intend to debate Mary about this.
So let's make that clear right off the beginning.
>> DR. BUSBY: Jayne, my understanding from the newsletter, it's also available at the BLM

District Office.
Is that right?
It's available online.
>> KATHIE LIBBY: I'll give you my card and --
>> DR. BELNAP: I will give you my card and if you could tell me how to find it, I would love it.
We don't do enough of it.
>> KATHIE LIBBY: Mary, he doesn't want to debate you, but if you have a question you wanted to raise to the panel in that regard.
No?
Okay.
You're welcome.
>> Participant: It looks at AUMs of an entire ranch, not just what's on Grand Staircase.
Looks at AUMs you have that you aren't using.
I think it's a good thing to have out there, and it's going to be good to respond to.
>> KATHIE LIBBY: Thank you.
We've got a question back here.
>> Participant: I'm just wondering, I don't know if you're the right people to ask, but the pamphlet said that the whole -- the new agreement will be based on values, Glen Canyon values and blah, blah, blah.
I don't -- what is -- what are the values of Glen Canyon National Recreation Area that are going to determine the outline?
>> I would think John Spence should answer that.
>> Boating on Lake Powell.
>> There you go.
>> Our values and purposes are derived from enabling legislation.
They're in the legislation.
They're very broad.
They're basically the resources like the vegetation, soil, water, wildlife, cultural resources, et cetera.
They're in some ways similar to the objects and values of the Grand Staircase-Escalante National Monument although there are differences.
I think the proclamation for the monument is much more specific in many of their objects to be protected.
Ours are a little more general but they're basically the resources that we look at and that we consider actions on the ground in terms of grazing management.
We look at impacts from various kinds of projects, including grazing projects, on the various values.
>> Thank you.
>> KATHIE LIBBY: Thank you.
Anything else from... from the public?
One more written down that I'm going to use.
It appears grazing in the monument will have to occur after February 15th on a rotational basis and some crust degradation will occur on those pastures.
Given the monument manage the plan's emphasis on restoration of biological soil crusts, how

can we allow grazing during a period where crust will be impacted?
>> DR. BELNAP: Life is a balance.
And I mean that.
We really need to think about the management goals and the mandate that is contained within the monument creation, and that includes grazing, and decide where that compromise and that balance is, and if there is one.
It's not not grazing and it's not total grazing everywhere at all times at high intensity.
That is a balance.
That's what I think we've been talking about all day.
There is an answer, but it's site specific, and there's these different components that need to be taken into consideration and then we can find it.
But it's a lot of work, and I don't want to brush over like, oh, it's easy.
Because it's not.
It's a lot of work, but I do think that there is a balance, and we've got to find that balance.
And I -- we were talking at lunch because maybe one of the models to think about is like the Forest Service in many areas, they don't combine motorcycles with mountain bikes, with hikers, with X, X, X.
They have areas where they do this.
They have areas where they do this.
So maybe if you've got areas of stunning soil crust that are very vulnerable, the soils are vulnerable to erosion, X, X, X, you don't graze there, but what you do there instead is that's where you have some other activities happening.
And I'm just making this up.
I'm just saying it's a balance and there's lots of ways to cut the pie and we need to be thinking about all those different ways to cut the pie to get at where we need to get and no one is going to be happy, and we know that from the outset, so that's okay.
You know, it's like no one is going to get everything they want, but everybody can have a big piece of what they want.
>> DR. ANDERSON: What you want to manage for and what you want to manage it.
>> DR. BOWKER: Multiple use doesn't necessarily mean every single square foot has to be used for everything.
We have almost 2 million acres here.
>> DR. BUSBY: You have to rise above the gridlock of Congress and the President.
>> DR. BELNAP: There you go.
>> KATHIE LIBBY: Well, I'm going to say two things.
One, we are completely open to additional questions.
We are completely open to additional thoughts from the panel.
My immediate instinct is that we've just talked about values, balance and hard work.
What a really interesting collection of -- what an interesting way to kind of come to some conclusion today, but additional questions, additional comments, and then I'm going to turn it over to Sara so that the BLMers can give you some sense where do we go from here.
>> Grand Canyon trust is in the process of undertaking a set of transects randomly generated across the monument this fall to measure crust using methods Matt Bowker had used in his original research, and we've done a workshop with him, and we're going -- we're also mapping

the monument in terms of the potential for crust, and I would be more than happy to have anyone here -- some people here are actually volunteers in that process, but I'd be happy to get your name if you're interested in coming out with us in the field sometime when we're doing this, because we're going to try to get a lot of those done in September and October, November when it's not so hot, so I would -- if you give me your name, I'll let you know dates we're going to be out there, and we'd be happy to have you see what we're doing, because we're trying to get that report prepared for the this EIS process.
>> DR. BUSBY: Just one thing, Mary, and I'm not familiar with exactly what Matt did, but I would encourage you if you're running a line transect, and that's what that word means to me, is that when you drop that pin, record not just the lichens that may be on the soil surface, but record the vegetation layers above it and record the bare ground.
Okay.
Because the reason for particularly the vegetation above it is you can start looking at -- you can start looking at your association where the biological soil crusts are still very present and very healthy maybe underneath something.
It would be cool to know.
>> KATHIE LIBBY: Additional comments from the room?
Yes, sir?
>> Participant: Is there a correlation between elevation and soil stability?
>> DR. BUSBY: There's a correlation between plant cover and soil stability.
So if you take highest elevation on this monument, 8,000 feet, 20 inches or more of precipitation, and you blade it off, rain or snowmelt is just going to go like crazy down the slope and it's going to carry everything with it.
There will be no soil stability.
Graze it off.
Whatever you want to do to it.
And so the key is to maintain as high a plant cover as you can possibly get because that's what brings the soil stability.
And remember these organisms we're talking are forms of plants.
>> Participant: So you are I saying the plant cover could be at the lower elevations to promote that stability?
>> DR. BUSBY: well, we've he said all day at the lower elevations you don't have the precipitation to create the root system for the deeper-rooted plants, you're not going to have a high amount of vascular plants, grasses, shrubs and forbs, and so at the lower elevations the crust become the key for soil stability.
>> Participant: Okay.
I just wanted to see --
>> DR. BUSBY: At the higher elevations with that kind of rainfall you might had 100% vascular plant cover, catches every rain drop, and basically prevents nothing from running off.
But it's the cover that's cool.
>>> I'm really interested in climate change, as you know.
This is -- or for any of you who can answer this question.
Given the worst case scenario of probably 20 to 30% decline in precipitation, which is the worst case scenario, and warmer conditions, we may become more like the Mojave Desert,

particularly at the lower elevations.
My understanding is Mojave Desert soil crusts are a little different in function and structure.
Do you think that's going to light move up onto the plateau?
Are we going to start seeing long-term trends in the plateau crust?
>> DR. BELNAP: We're already seeing them.
But I forgot the function part.
So we're seeing a loss of the more northern lichens.
They're kind of exiting the system.
We're seeing some of the southern desert lichens increase in cover.
But that does have large implications for the function, because one of the big guys we're losing is one of the major nitrogen fixers, CHOLEMA.
So this is a big deal.
This is a big deal.
There is a more southern one, but it's lichen movement is going to make the tortoise look like the hare.
So I think about, and just this slow mixing of everybody trying to slowly -- what's going to happen in the middle we don't know.
Everybody is going to be moving up, but how things will sort out in the middle.
But I do think -- on the other hand, I should say that the southern deserts have much more active cyanobacteria, so they can have some pretty impressive succession rates, but it's still not to the rate we have now.
So I'm expecting that we will see less nitrogen input as that flora shifts, especially before the southern guys get here, because there's kind of a vacuum that's going to be left because these guys are so slow.
And I don't -- about the soil stability, I think probably the same thing, whether we're going to have this kind of zone where the new guys aren't quite here yet.
I should add that mosses and lichens are way better at stabilizing soil than the cyanobacteria and the reason is they grow above the soil surface.
From water erosion, the most erosive thing is rain drop impact.
When the rain drop hits the mosses or likens, it doesn't move the soil.
The sigh answer owe bacteria are in in the soil and it can hit the soil and bounce off soil particles.
Same with wind.
The wind Nevada hits the soil surface moss or likens.
So while the other guys are moving up and our guys are leaving, there is probably a lot less lichen and moss cover, and plus overall there's a lot less moss and lichen cover in the southern deserts.
So we expect to end up with a lot less, which means we will have probably less soil stability in that sense, and they're flat.
Not much bumpiness.
So we can be looking at differences in the hydrologic function.
Will they retain as much water?
I don't know.
We don't know what mixture we end up with.

But I'm sure they'll alter water infiltration rate or something.
Expect big changes in function but it's hard to know.
>> DR. BUSBY: Somebody during one of the questions I think made the question of red brome.
Is it routinely moving up into this country?
>> Yes.
>> Big Canyonlands.
>> KATHIE LIBBY: Okay.
Oh...
>> Participant: Do soil crusts in their own become overmature or will they collapse as plant communities?
>> DR. BOWKER: We don't have any evidence of that.
There is a succession within crusts as we go from a light cyanobacteria to dark cyanobacteria.
And in certain areas it will turn into continuous moss or lichen or a mixture cover.
But they don't really collapse like you say.
I would say they persist as a late successional element of the ecosystem.
>> Participant: do those plants within those clusters die?
>> DR. BOWKER: The vascular plants?
>> Participant:, no, the individuals critters within that community.
>> DR. BOWKER: I see.
So -- yes, I'm sure some stems do die, but a lot of these species are mostly clonal.
So -- I don't know how many individuals you're losing there.
>> DR. BELNAP: A do you mean the cluster -- or the vascular plant.
>> Participant: Not the vascular.
>> DR. ANDERSON: I know with likens, at least those growing on rocks and trees, oftentimes the center parts will die out but the margins are still alive.
So I would assume the lichens are doing something similar.
We just -- it's not obvious and you don't see it.
>> DR. BELNAP: And I actually just saw a bunch of photographs with -- with a colleague I was visiting where the different little pieces you can see on the surface are connected by a Fungal spread to another one and connected by a Fungal spread to another one.
It's going all through the soil and they're all one individual that are connected by these Fungal threads.
I was amazed.
I was like, wow!
So it's very likely that even if this guy over here dies off, you know --
>> Participant: Just like --
>> DR. BOWKER: Still a piece of him somewhere else.
>> Participant: Just like Aspens.
There are stems that die.
As long as the stand is healthy it will be replaced bias pen sprouts.
So there's death and regeneration going on all the time.
>> DR. ANDERSON: Now that I think about it, they do.
Looking at specimens I've collected, you know, sometimes I think I've collected something new or unique, and you get to looking at it under the microscope you realize, it's just -- it is dying

out, though there's some live around it.
So, yes, they will do that.
>> Participant: There was recently published some cool stuff and this ties in with John's climate change question.
They were looking at changing the rainfall pattern.
So they kept the total amount of rainfall in the summer the same but in one treatment they doubled the frequency.
So you get double the amount of Littler, smaller rain events, and this caused first the mosses to die, 90% of them died, due to that stressor.
So that's the really alarming possible climate change trend, would be more frequent, short duration wet events, because each one, every time these crests wet up, they need a little period of time to come to a point where they're reaching a net carbon gain, and if they don't get there, then they're losing carbon and then they sustain some damage when they dry down again, and if you just keep doing that and doing that, it's like a boxer getting hit in the kidneys and eventually you fall down.
>> DR. BELNAP: Wow, what an image.
>> KATHIE LIBBY: Okay.
>> Participant: I thought you had a question behind Jim.
>> KATHIE LIBBY: No.
Okay.
You're going to get a closing comment, right?
So...
>> Participant: Just to follow up on what was being discussed, I'm curious about the uniqueness of the moss, lichens we find on the monument.
How unique are these?
Are they pretty widespread?
>> DR. ANDERSON: I can think offhand like fogencia that occurs on the monument.
I haven't seen that too many other places.
But a lot of them that occur here I have seen -- like I said, I've done research in New Mexico and Arizona.
I've seen them in those areas.
COLEMA seems to be a widespread species.
I've seen that in northern Utah up around flaming gorge.
So I think for the most part a lot of the species that we have are widespread, but there are some that are -- not necessarily unique.
I mean, there are other locations where you find fogencia, but it's not something I've seen in like the northern part of the state.
So there are some.
It depends.
>> DR. BOWKER: I would say the place you want to look is on the gypsum soils.
There are a number of unusual species there.
For example, gypsoplaca macrophylla is a globally rare lichen.
It's go a really strange distribution.
For some reason it's in Greenland.

But it's also on gypsiferous soils in Utah.
I can't explain that.
But that's how it -- only species in the entire genus, and even in that unusual habitat, it's a rare species.
There's -- common in other places in the world but rare in North America is -- another gypsophyle.
I saw it everywhere in Spain but you don't see it everywhere in the United States.
Lichenora gypsicola was first described by, I think Larry St. Clare, and that was in the '90s, first described in the '90s from capital reef and you have it here.
Dygemidon was first described in the 1990 near Las Vegas and we have it here on gypsum soil.
So the gypsum, I think, is the wild -- it's the wild community.
>> KATHIE LIBBY: Anyone else?
There will be plenty of follow-up.
The LiveStream will be available.
Transcripts will be available and more information will be forthcoming, but let's ask Sara and maybe Matt to come up.
They have been listening all day not only to the panel but to your questions and interest.
And the question is what next.
>> What's immediately next, and I'll let Matt follow up with what's next, but what's immediately next, and I think Richard and I share this, is to thank our panel.
I want to reiterate some of the objectives we had for this and wanted to share our current scientific understanding of biological soil crusts and gain information about this set of critters that will help us draft management alternatives for our livestock grazing amend, and we want them to be able to answer questions from people who have a vital interest in not only grazing on the monument but also on biological soil on the monument and all other monument resources and I think we met those objectives, and I want to commend our panel.
We had asked -- you were all strangers to me who I reached out to on the phone, thanks to a team that included commissioner Jim Mattson and Brian Brimner, Carmen Bailey, John Smith, Mary O'Brien was instrumental in helping us do this.
We put together this list of folks that I was asked to just cold call, which I just hate doing.
That's why I'm not in journalism anymore.
And asked if they would help us.
And I want to thank you all, Janis Boettinger, you were fantastic.
Hooray for soils and soil mapping.
Hooray, hooray.
And Matt Bowker, we've been talking about you forever with your potential maps, and I see the potential for research is just unbounded.
Jayne Belnap, you didn't wear your red shoes or if you didn't we can't see them under the tablecloth but you have been an incredibly thought provoking speaker.
Kim Anderson came back to the monument, for which I can't thank you enough, and stimulated a lot of really good discussion.
Aided, of course, by Fee Busby, which I know he's ready to leave any minute.
He has been threatening all day.
You have been a fantastic panel.

You were so good.
And can people -- is it okay if we have a round of applause for our panel?
Really, really, just incredible work.
And more than anything I think we really met our objectives here, and audience, you were fantastic, too.
The questions were just brilliant.
Really going to help us.
So I wanted to just say thank you just in helping us with the process we've all engaged in.
I think I heard someone earlier today, I think it was Kathie, talk about this is a collaborative effort to work together and as we heard today it's going to take a lot of partners to work the issues we have been talking about.
So I wanted to ask Richard if he has some final things to say.
Richard is our resources division chief for the monument.
>> Thank you also.
Thank the panel also for coming and taking part with us.
Just a couple things that I have heard today is, number one, is we do need more science and research in the right areas to help us out.
What can coexist with crust and how do you get it there?
A couple of questions answered.
Possibly not be managed for all locations.
Be flexible.
Use and trust the info we've already painstakingly went out and collected.
And the bottom line, and always the drag of the whole party, is now we got to round up financial resources to help make that happen.
And so those are some of the things that I think I'm taking away which we can work on.
>> Well, good afternoon, and thanks for staying with us.
My name is Matt and I'm Planning Division chief at Grand Staircase.
I work with Richard and Sara here.
Thank you, panel, and thank you audience, for the participation.
You know, Fee kind of hit on there was a process in place that began over 10 years ago for this livestock grazing EIS and it did get extinguished at some point and we renewed it this November and we went through the scoping process and BLM has made a commitment to see this planning process through.
It will not die on the vine like the last process.
We have made a commitment through designating budget, bringing on contractor support, and putting on forums such as this to help us get more information and get through the process and keep the communication lines open, and so I want to reinforce that this is not -- it's not going to be a duplicate of what happened previously.
But, again, as I mentioned, we did start this planning process again, reinitiate it here in November.
Our next steps, and we did go through a comment period there, a scoping period where we took comments from the public about livestock grazing on the monument.
We also completed a socioeconomic workshop series through some of the local communities here, and we do have a socioeconomic workshop report posted on the monument's Web site

and if you just go on the Google and look at BLM and GSENM and click on something that looks like planning or livestock you'll end up on some of these document.
And those are out there.
The analysis of the scope reports the analysis of what we heard from the public that's posted out there as our scoping report and then also the results of the socioeconomic workshops.
So what's next?
You know, we have this great information that you wanted, and there was a lot of information related to range improvements, land treatments, general biological crust information.
That's good outside -- just outside of the livestock EIS.
Some of that will flow into the livestock grazing EIS through the analysis of our alternatives, which is what we're getting ready to do next.
Right now we're working with our cooperating agencies, which is Garfield, Cane County, state of Utah, National Park Service, NRCS, some of these other governmental organizations, and we're getting ready to dive into the alternative development piece where we're really going to take a look at some of the opportunities we have, and some of these management actions that have been described by our panel today in relation to biological soil crusts but also into all the other resources that the monument manages for as well.
So that's what's coming up.
And what you can expect to see from the alternative process here is this fall we will release a preliminary draft set of alternatives to the public so everyone will have the opportunity to comment.
Typically what happens with these planning processes is BLM or an agency may go to scoping, listen to the public, and then we kind of go into a closet and look at the comments and come up with some draft alternatives.
In this situation we're going to go ahead and release those to the public and allow everyone here to take a look at them, make comments on them, and, you know, possibly adjust those alternatives before BLM and the cooperators -- we spent a lot of time and effort taking a look at those alternatives through analysis.
So we hope you take the opportunity to participate with that.
But longer term, the actual draft EIS, the big document, should be out the fall of 2015 with a final decision probably within nine months, 12 months after that.
Any questions about that?
Okay.
>> All right, if we're still on, I think we can turn off.
That was really excellent.
Thank you all very, very much, and we really appreciate your working with us on this.
Oh, we have to thank Kathie.
Stand up and take a bow.